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# Planning in Knowledge Intensive Contexts: Systems Supporting Memory Tracing

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*Abstract*— In the spatial planning domain decision-making processes are carried out in knowledge intensive environments and aim at developing spatial plans as sort of future scenarios containing strategic prescriptions. These scenarios evolve along the decision making process and together with the emerging and evolving cognitive context. Consequently, tracking the assumptions, values, experiences, conversations, and decisions as they evolve along time, is relevant for decision making and enables better informed reflection for the plan development. In order to take into account the temporal dimension of knowledge in plan generation, and not only in the plan itself, we designed MESS, a MEMory Support System able to sustain a dynamic representation of the memory of the organizational field of intervention.

In this paper we discuss the theoretical environment we referred while designing MESS and describe the system architecture.

*Keywords:* *memory component; knowledge intensive contexts, organizational memory; scenarios*

## I. INTRODUCTION

In spatial planning domain decision-making processes are carried out in knowledge intensive environments and aim at developing spatial plans as sort of future scenarios containing strategic prescriptions. These scenarios evolve along the decision making and together with the emerging and evolving cognitive context. Consequently, keeping trace of the assumptions, values, experiences, conversations, and decisions as they evolve along time becomes relevant for decision making [1] and enables better informed reflection for the plan development.

In order to take into account the temporal dimension of knowledge in plan generation, and not only in the plan itself, we designed MESS, a Memory Support System able to sustain a dynamic representation of the memory of the organizational field of intervention.

In the following we'll be referring to three research areas: Organizational Memory, Design Rationale and Spatial Planning, so some theoretical introductions are needed to make sense of our problematic context.

Organizational Memory (OM) is an umbrella term utilized when referring to the way organizations use and maintain knowledge in different forms [2]. The need to explore OM

concept in spatial planning field starts from the stance to consider information and knowledge (used, shared and/or produced in these processes) not as passive records to be stored in a database but as dynamic contents living and changing along the time and with the organization evolutions [2]. Furthermore in spatial planning, when dealing with OM a distinction is fundamental between long-term and short-term OM. Long-term OM refers to those structures and contents of OM being stable like values, principles, cognitions shared throughout the planning organization; short-term OM represents essentially working memory [3], it is deeply related to a specific decision making process and is relevant for supporting the decision process itself [4]. Short-term memories are evolving entities supplying contents and knowledge to long-term memory throughout other mediating memories. A relevant mediation role between the short-term memory and the long-term memory is played by the decision rationale (DR), considered as an intermediate memory.

Following an argumentative approach to DR theory, we refer to DR as the relevant part of argumentation contents explaining the reasons behind decisions [5]. Within a decision-making process DR is the decisional path building and explaining causal links from preliminary assumptions to final decisions. In such a view argumentation becomes crucial due to its role both in: i. making DR explicit, and ii. explaining modification of the working short-term memory along time; the research will refer to such modification process as a sequence of cognitive transactions which shape the evolution of short-term memory contents.

Coherently with this theoretical basis the paper first presents the methodological and technological framework for capturing and making available short-term organizational memory in order to support knowledge intensive decision making processes; finally it presents MESS, a MEMory Support System implemented during a recent research work of the authors, and discusses the role of argumentations in the development of causal links explaining a plan as product of the planning process.

## II. MEMORY SYSTEMS: WHAT PERSPECTIVES

As above remarked, the construction of environmental plans must be intended as a social activity in which evolving plans are (judged) able to guide the participatory action and

make it converge. In such cases, the knowledge (often tacit) coming from participative processes could be considered as a value and utility only when it is able to stimulate collective, practical and more or less shared reflections [6].

The access to the knowledge developed by the decision making process during the process itself is particularly relevant for the plan development process since it strengthens the support for reflection, enables re-experience considered fundamental mechanism for learning, [6] and widens the opportunities for decision making.

A plan developed in a participatory environment should focus not only on the substantive character of medium/long term visions but also, and especially, on the decisional system explaining those visions. Such a plan needs to evolve together with its decisional system and, consequently, to incorporate the continuous modifications that collective reflections produce on existing prospects, interpretations of the involved actors, and preliminary remarks explaining the decisions [6].

The need to explore the concept of organizational memory in participatory planning experiences starts from the stance to consider information and knowledge (used and produced in these processes) not as passive records to be stored in a repository but as dynamic contents living and changing along the time and coherently with the organization evolutions. It is important not only capturing and storing the history of the decision making process but also making it accessible for further and continuous interpretation and exploration along the process itself and by all the members of the organization, i.e. the stakeholders involved in building and using that memory day by day.

In environmental planning, capturing the Decision Rationale (DR) underlying the process itself and making it available to participants [7] [8] [9] could be considered functional to the need to mediate between the short-term organizational memory and the long-term organizational memory.

Long-term organizational memory refers to those structures and contents of organizational memory being stable like values, principles, cognitions shared throughout the planning organization; short-term organizational memory represents essentially working memory [10] [11]; deeply related to a specific decision making process it is an evolving entity supplying contents and knowledge to long-term memory throughout the DR considered as an intermediate memory and a stepping stone towards long-term organizational memory.

Argumentation becomes crucial. It has a double role both in: i. making DR explicit, and ii. explaining the modifications of the short-term memory (or working memory) along [12] [13] such modification process as a sequence of cognitive transactions [14] [15] [16] from one version of plan to the subsequent.

Our interest is not only in knowledge in itself but also in the underlying context of knowledge and in the process that created that context of knowledge at the time it is created [10]. Information systems, supporting such processes, need to be developed having a content repository and a context repository, both structured and organized in a process memory. In these

systems argumentation would represent not only a relevant component of the DR [17] [6]; but also the power engine of the plan evolution. Therefore, the process memory, referring to the tracing of the DR, has to include both the knowledge evolution and also the argumentative base explaining such evolution.

In order to consider the temporal dimension of both the plan generation process and the plan itself, ICT systems should support the dynamic representation of the memory of the organization involved; indeed, such representation of the memory has to be considered a tool to “store” and exchange knowledge but also a mean:

- to make explicit (and then visible to the users and system manager) the cognitive conditions and the argumentations generating the transactions from one version of the plan to the subsequent and
- to explore the operability of the current plan.

Starting from the model briefly described above, we are exploring the opportunity to represent dynamically the process memory within ICT environments by enabling the development of what we defined process-scenario that is a scenario which evolves together with its related decision making contexts and with the action itself. In a sense, the process-scenario includes the process-memory (the Design Rationale as the reasons behind spatial planning decisions) and the short-term memory (the current version of the plan).

The short-term memory has got a deeper operative role: it represents the support of the operative environment where decisions are made and, at the generic time  $t$ , contains the current version of the environmental plan and the whole cognitive content developed, acquired and created referring to that version. This last would promote shared understanding at time  $t$  about the context situation but does not have long-term value; it is just part of the process-scenario.

Coherently with the considerations above, the Organizational Memory System we are developing allows: i. to record and assist the knowledge generation and management (expressed in several media: graphs, images, texts, video, audio, etc.), ii. to keep trace of the history of decision, giving a structure to the memory of the complex “ephemeral” organization [18] emerging all around the participatory planning process, iii. to extract from history specific or new contents which are, or become during the process, “the focus of discussions and actions”; finally, iv. to trace the contents evolution and modifications along the process.

### III. MESS AND ITS ARCHITECTURE

#### A. Aims and scopes

MESS is a process memory support system designed according to two principles:

- knowledge is not important in itself but it make sense in the underlying context of knowledge and in the process that created that context of knowledge at the time it is created;

- argumentation represents not only a relevant component of the DR but also the power engine of a process evolution. Therefore, a process memory has to include argumentation rationale as the contents explaining reasons behind process-evolution steps.

MESS has been designed aiming to the following objectives:

- to have a content repository and a context repository, both structured and organized in a process memory framework;
- to include both the knowledge evolution and also the argumentative base explaining such evolution.

MESS architecture consists of three main modules: two workspaces and one “history” space.

The first one is the workspace for knowledge sharing and exchanging: it consists of a collaborative knowledge repository for on line consultations. The main objective is to open on-line discussions about specific topics enlarging participation to a wider community on the web.

The second is the workspace for textual and geographical annotation. The workspace is designed to pursue two main objectives: i. to trace open contents evolutions, ii. to explore the contents following the argumentation rationale. This is the environment where DR for on line discussions are traced.

The third is the “history” space. This is the space where the process history is structured and represented; here different knowledge from different sources, generated in different times, and with different mediums makes sense of the whole process.

The paper will describe in details the system features and functionalities showing how the three workspaces, working in unison, give shape to the OM as we conceived it. MESS has been designed for the Torre Guaceto Park Agency in order to support decision making throughout the planning process. The system has been developed to support the entire planning process by providing an integrated collaborative environment as structured space for participatory decision making. In such a collaborative environment knowledge is activated as a resource by the users who form relationships, act together, share and reflect collectively on their knowledge and beliefs.

By taking trace of shared experience, context, and communication about interpretations and reflections on information and knowledge, the organizational memory in MESS becomes dynamic, relational, and coherent with the collaborative action.

While designing MESS the attention was focused on two main issues:

- transferability and accessibility of the memory;
- easy understanding of the interaction process.

The first issue refers to both the problem of archiving information and knowledge and the problem of information and knowledge retrieval from the memory although this memory is rapidly growing in dimensions and diversification [4]. MESS builds and manages a sort of collective memory

using different kinds of relations: two standard indexes (semantic relations and geographic relations) but also indexes of process (dates, discussed issues, ...) and indexes of context (actors, protocols of participation and decision making). In MESS different indexes can simultaneously characterize a relation; different paths for memory exploration are possible and are always available to the user.

The second issue derives from the need to enable an easy understanding of the advancement of the interactive process with regard to its origin, its ultimate goals, the interaction contents, and the different cognitive position of the actors. We wanted MESS to make the decision-making history and its content explicit and available not only to current users but also to newcomers; the more rarely the user makes use of the interaction space, the greater accessibility is reduced. For this second goal the traceability and the transparency of the process (the process memory) become relevant: the process traceability is important for enabling process access to “non ordinary” users, that is to newcomers (Märker and Pipek’s perspective, [19]), and in our case it is a basic issue in order to facilitate creation of feedback and reflection.

In designing the system, the main purpose was to organize a dynamic representation of the collective memory considered as a means not only for accumulating and exchanging knowledge but also for tracking the decision making history. In such a way the collective memory provides a context with supportive and formative functions [20] [21] [22] since MESS permits the decisions to be tested, retrieved, collated, combined, and evaluated over time.

In MESS, by tracing the process history, knowledge is stored in a dynamic format following the decision process dynamics: knowledge is embedded in the process and the process is used to structure knowledge. At  $t = t_n$ , a set of argumentations (based on observations/argumentations and related comments) is associated with the current decision making hypothesis and can activate the transition from that hypothesis to the subsequent.



Figure 1. MESS: the interface in the Argumentation Support module

## B. System roles

Within the approach described above MESS can be viewed as:

i) a *facilitator of communication and manager of argumentative discourses*

In addition to the generic functions for viewing, browsing and communicating to other users (supported by synchronous and asynchronous work environments), the system facilitates retrieval and shows and manages dependencies between memory contents. This function is organized in a workspace, an ARGUMENTATION SUPPORT module. In this virtual space memory is updated by the introduction of: i) issues, topics about which discussions are carried out; ii) observations, expressing some positions, in the form of statements, relevant to the issue; iii) comments, presenting statements in favour or against particular positions (arguments or counterarguments). The work environment supplies support for geographic or text-indexing of the information and/or knowledge introduced in order to structure the archivation of contents in order to catch chains of argumentations explaining the transactions.

ii) a *builder and manager of a dynamic collective memory*

The asynchronous communication managed by the argumentation support module enables re-experience but, above all, it represents a discursive platform where knowledge and contents are transformed, reflected upon, and re-combined by the collective mind. Therefore, the main task of the COLLECTIVE MEMORY module is to record contents and structures of collaborative dialogues and to make them available to the users. Such a collective memory can be considered organized in a repository of content, a repository of process, and a repository of contexts:

- as repository of content, it contains and manages knowledge created and manipulated by the organizational structure taking shape along the collaborative planning process;
- as repository of process, it captures and maintains the knowledge of the process itself in the form of process designs, case histories and lessons learned from past experiences by the users [23] [24] [4];
- finally, as repository of context, it contains and manages information and knowledge related to the organization and structure of the evolving context.

In such a way the collective memory evolves together with both the cognitive frameworks acting on those contents and the related decision making system.

iii) an *assistant and advisor of the decision process*

MESS provides a participatory decision forum (in the DECISION SUPPORT module) whose results can advice and improve the quality of decisions related to the setting up and management processes of the Torre Guaceto wet land. The system is designed to assist debates by tracking the various claims and arguments, by searching repositories for relevant information and knowledge (by the exploration of the dynamic

memory), and by continuously updating and assessing the overall state of the decision making process.

There are two modes in which the memory elements are managed in their evolving framework in the system; i) by tracing collaborative discussions carried out in all asynchronous, synchronous, and vis-à-vis environments; ii) by supporting decision making activities oriented to the collaborative plan development.

At time  $t$ , the user can access all the contents through the current version of the plan representing the portion of the decision space which the users are currently working on. The version of the plan at generic time  $t_n$ , therefore, represents the key to access both the argumentation chains explaining the modification until time  $t_n$  and the argumentation chains envisaging future possible modifications.

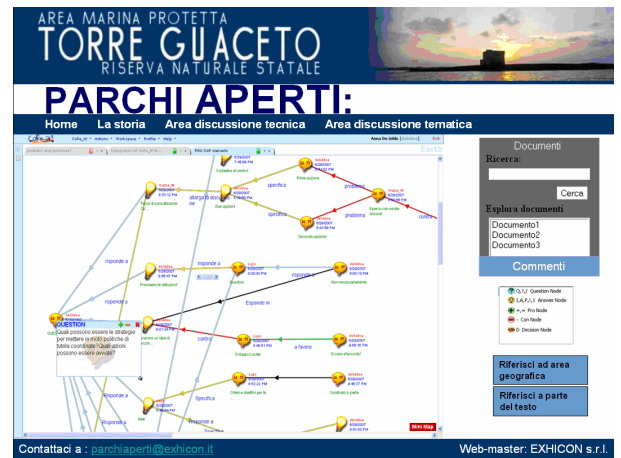


Figure 2. One of MESS interfaces in the Collective Memory module

## IV. CONCLUSIONS

The paper explored the concept of organizational memory in participatory planning considering information and knowledge, used and produced in participatory processes, not as passive records but as dynamic contents living and changing along the time.

Since the ability to monitor and manage knowledge in participatory planning action is crucial for the effectiveness of the action itself, the paper proposes memory support systems as opportunities to orient knowledge management to action. In such systems the focus on the argumentation content is combined with the necessity to merge argumentation and environmental planning issues in a sort of memory, the process-memory, which is considered relevant for two main reasons: i. it supports effectively the environmental planning decision making process and; ii. it represents a sort of cognitive guide to orient action coherently with the indication contained in the environmental plan.

The memory system prototype we are developing for the Torre Guaceto Park Agency stresses the tracing of the decision rationale; large effort still needs to be devoted to make this

tracing more effective, less energy and time consuming and then consequently to produce contents which are available during the planning action so that these can be used from the community in order to support the action itself.

At the moment using the system requires technical skills; both knowledge classification skills and technological training with the Knowledge Management tool are needed.

Future research efforts will be devoted to complete the implementation of the memory system by improving functions oriented to the structuring and re-using the knowledge contents.

The reflections and the approach proposed in this paper derive from experiences and observations carried out in the environmental planning domain. It refers to plans development activities and, in particular, focuses on potentials of knowledge management in supporting the creation, management and use of evolving organizational memory in collaborative decision support systems.

Generalizing, our reflections and approach could keep their validity in those domains where: i. decision making is characterized by collaboration and knowledge intensive interaction among stakeholder and ii. strategic planning activities are carried out in a futures visioning approach; ii. the dynamics of organizational memory is relevant for knowledge management and decision support.

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